BIG DATA.
BIG ENERGY.

[GREEN IT STRATEGY WHITE PAPER]

HARVARD UNIVERSITY | Sustainability

HARVARD UNIVERSITY
Information Technology

HARVARD'S GREEN IT COMMITMENT

Achieve University-wide compliance with the Harvard University Sustainable IT Standards by 2017.

Like any research and teaching university, Harvard faculty and students increasingly rely on high-performance research computing (HPRC) to tackle big data and solve computationally complex problems that are too large or would take too long for stand-alone desktop or server computers.

When the Faculty of Arts and Sciences Research Computing (FASRC) department was founded in 2007, one of the first orders of business was to build Harvard's largest supercomputer, nicknamed Odyssey, to support the growing demand from research fueled by big data.

Comprising 60,000 CPUs with 15 petabytes of data storage, Odyssey today occupies more than 9,600 square feet of space across three locations in Massachusetts. In one day, Odyssey's cloud computing power can process the same amount of data that it would take a traditional desktop computer 140 years to do. It processes data for research being performed by Harvard faculty, including a project called the Connectome that is unraveling the wiring diagram of the human brain, the Large Hadron Collider at CERN, and a massive telescope at the South Pole that aims to record evidence of the Big Bang.

Odyssey is energy-intensive, requiring 1.5 megawatts of electricity for computing and cooling, with a growth rate of 250 more kilowatts annually.

Siting Odyssey on the Harvard campus would have meant emitting between 4,000 to 6,000 metric tons of carbon dioxide equivalent each year.[1] The growing need for more HPRC to support the University's mission, while simultaneously balancing the need to reduce energy in order to meet the University's emissions and energy reduction goal, was a challenge that needed to be addressed.

A pillar of Harvard's sustainability initiative is aligning the diverse and decentralized university community around shared strategies that provide individual Schools and departments the autonomy to create their own success. The Sustainability and Energy Management Council (SEMC), composed of facilities and operations leaders across Harvard's schools and departments, is a key part of this strategy. The SEMC was established by the Office for Sustainability to facilitate best practice sharing and to collaboratively develop sustainability and energy management policies that would drive continuous improvement. Subcommittees are convened by the SEMC to research and propose recommendations for common challenges, including the Green IT subcommittee launched in 2009.

[1] 1.5 MW = 1500 kW * 8,760 hours = 13,140,000 kWh * 0.000316 MTCDE on Harvard's campus = 4,200 MTCDE; figures are estimates based on variations in sources of energy supplied.

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2017 GREEN IT STANDARDS

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GETTING ORGANIZED: Setting a baseline with a needs assessment

The **Green IT subcommittee** of the SEMC was organized to explore and implement best practices and innovations for data centers, end points (personal computing), purchasing, e-waste disposal, and printing.

The University's decentralized structure—a central administration with 13 independent schools and units—meant that there were multiple IT departments with individual cultures, goals, and a wide variety of demands. Just as the SEMC was a groundbreaking governance structure in helping facilities managers throughout Harvard share ideas and resources regarding capital improvement, the Green IT subcommittee was among the first such bodies to bring together a unified body of Harvard computer specialists.

FAS Assistant Dean of Research Computing James Cuff, along with Eric D'Souza, a Harvard University IT Senior Project Manager (and previously with Harvard's Real Estate division) and Harvard Business School Director of Facilities Doug Scatterday, co-chair the subcommittee. The group has representatives from all of Harvard's 13 Schools and units' IT and facilities leaders bridging across disciplines.

Improving the energy efficiency of Harvard's data centers was, by and large, the subcommittee's most ambitious and substantive effort. An additional challenge of high-performance research computing is the high cost of large-capacity computing infrastructure with often intermittent usage.

Taking into consideration the substantial individual research computing needs at Harvard Medical School, Harvard Business School, the School of Engineering and Applied Sciences, and the Faculty of Arts and Sciences, the Green IT subcommittee started off with a campus-wide assessment that provided a baseline for future planning.

This created the foundation for an initiative to shut down the University's older, less efficient data centers spread across campus and working off the efficiencies to scale by collaborating on the development of a larger off-campus research computing center.

LESSONS LEARNED:

- Involve professionals across the entire organization
- Evaluate existing IT needs and set a baseline for future planning

SEEKING COLLABORATIVE SOLUTIONS

As the Green IT subcommittee began its work, research universities throughout the Boston region were facing similar issues. Harvard and MIT joined forces with Boston University, Northeastern University, and the University of Massachusetts, along with the Commonwealth of Massachusetts and industry partners, including EMC^2 and Cisco, to address the issue of computing space, expense, and energy management by funding the construction of a high-performance research computing facility in Holyoke, Massachusetts, called the Massachusetts Green High Performance Computing Center (MGHPCC).

The LEED Platinum MHPCC opened in 2012 and today provides Harvard with enough computing power to process 1,500 terabytes of data. The project is a positive example of the power of partnership and collaboration in solving complex sustainability challenges.

"Because MGHPCC is a consortium, risk is mitigated since it is difficult for any entity to predict demand with precision," says Cuff. "And as a consortium, there is great flexibility to share resources with partners."

MGHPCC also mitigated cost outlay, as institutions could pool their resources and share access to a world-class research computing center. Each institution invested $10 million toward the $90 million facility, a significant savings for Harvard if it had built an equivalent research computing center on its own.

Creating an offsite research computing center frees up an estimated 6,800 square feet of data center and computing space on Harvard's campus, with a target of an 80% reduction in research computing use on campus over the coming months.

In addition, energy is cheaper and cleaner: electricity rates from Holyoke Gas & Electric are about two-thirds the rates in the Boston area. Approximately 67% of Holyoke's power supply is renewable, provided through local renewable hydroelectric generation, solar, and wind.

LESSONS LEARNED:

- Foster cross-sector partnerships and collaboration to fuel innovative solutions and yield great impact
- Shared resources off campus can free up limited real estate on campus for teaching and research uses

STRONG SENIOR LEADERSHIP: Drives alignment and action

Executive buy-in and cross-departmental leadership were key to the early successes of the Green IT subcommittee. Harvard's Chief Information Officer Anne Margulies and Office for Sustainability Director Heather Henriksen's involvement provided the cross-departmental synergy needed to launch an effective working group.

Key to the subcommittee's success was the influence of an early champion, Jeremy Bloxham, Dean of Science at the Faculty of Arts and Sciences, who pushed to make sure that faculty was given incentives to think sustainably. For example, he made sure that computing capability —such as storage—was part of faculty recruitment and promotion packages, rather than financial incentives.

Cuff, who reports to Dean Bloxham, was also given a dotted-line reporting relationship to University CIO Anne Margulies. This was one of the first steps taken toward developing systemic accountability for sustainability measures.

Prior to this change, efforts to make improvements in energy efficiency and other sustainability measures were left up to individuals who, without empowerment, found such efforts difficult to prioritize.

LESSONS LEARNED:

- Sustainability directives from senior leadership are imperative to leveraging support
- Incorporate accountability for sustainability measures into the organization

ILLUMINATING THE "HIDDEN" COSTS OF COMPUTING

Before the construction of the MGHPCC, responsibility for tracking Harvard's data center energy and utilities expenses fell to facilities managers. While IT personnel were making procurement decisions and responding to institutional directives to expand research computing resources, factoring in the total embodied cost of new electronics—including annual energy costs—was not in alignment with their bottom lines, but rather the responsibilities of Facilities personnel who had no control over IT's purchasing decisions.

At Bloxham's urging, Harvard's FASRC department made a key decision to shift the utilities budgetary line item responsibility the FASRC budget. This small change made a world of difference: now decisions regarding purchasing and sunsetting old equipment included the cost-benefit analysis of whether such electronics also made sense from a sustainability and energy cost standpoint. This change was enormously influential in performing more comprehensive cost-benefit analyses—now, the entire life cycle of equipment could be factored into purchasing decisions.

"Ultimately," says D'Souza, "economic incentives drive behavior change. The cost savings associated with lower utility bills and better decision-making on computer equipment are enabling us to invest in newer equipment that would have otherwise been more challenging to pay for.

Energy cost savings create a virtuous cycle that helps us allocate resources more effectively and show the multiple benefits of sustainability."

That said, D'Souza cautions, the dramatic savings from initial changes are often one-time cost benefits, and should not be relied upon as an ongoing income source.

For most institutions, regardless of kind, greening one's business practices may involve committing resources toward projects with long payback periods, a large capital expense outlay, or both. While sustainability may be an institutional priority, other projects—fixing a leaky roof or upgrading computer systems, for example—take on more urgency as a means of carrying out the business of the day.

The most financially logical integrations of energy conservation measures are those that piggyback on existing opportunities. When Harvard launched its new Faculty of Arts and Sciences Research Computing department in 2007, faculty and staff knew that the burgeoning field of research computing would require a substantial expansion of its existing data storage capacity. Knowing this, as well as understanding its limited real estate within the immediate vicinity of its campuses, enabled Harvard to seize the opportunity to integrate cost-beneficial sustainability into its short- and long-term planning.

LESSONS LEARNED:

- Combine energy and computer purchasing expense management within the same job description to align accountability for total costs
- Take advantage of long-term capital improvement opportunities to integrate sustainability considerations in the planning process

CULTURE CHANGE AND EMPOWERMENT

Cuff and D'Souza vehemently agree: collaboration has been the key to successfully implementing Harvard's Green IT Strategy. President Drew Faust, School Deans, and senior leaders have all established sustainability and acting on climate change an institutional priority. A University-wide behavior change campaign led by the Office for Sustainability (OFS) raises awareness of sustainability, and gives students, faculty and staff the tools and resources to tackle on-campus sustainability challenges. OFS also facilitates opportunities for people at every level of the University to collaborate on common issues and develop shared solutions.

Embedding "sustainability" criteria within job descriptions and emphasizing collaborative decision-making across campus helps ensure that the voice of sustainability remains at the table of every departmental decision-making process. But, since sustainability efforts are often voluntary, a network of environmental stewards within the organization is critical to keeping a focus on sustainability when new projects are rolled out.

"Sustainability efforts have to be a coalition of the willing," says Cuff. "Leadership does play a role in setting the tone, but in our experience, advocacy coming from all layers of an institution—from the dean to the researchers themselves to the administrative staff—ensures that a lot of smart people are making sure that sustainability is an integrated part of how we operate."

In an institution such as Harvard—again, a somewhat loose coalition of independently operating schools—the "decentralized aspect is its asset," Cuff says. "It would not have worked if we'd had a green IT czar," because the varied cultures, processes, and approaches to sustainable IT practices across Harvard's different schools have led to multiple creative solutions within the institution, rather than just one approach.

While some aspects of Harvard's new IT strategies are collaborative, other decisions remain the domains of each of the Schools or administrative departments, which is especially important in an environment that thrives on creativity and autonomy. So the challenge the Green IT subcommittee faced was to develop policies and campaigns that created alignment, but with enough flexibility to allow for tailored strategies at individual schools and departments.

Cuff believes the University has established a new norm: a culture of sustainability throughout the campus. That culture empowers people to act within their area of expertise, and has been the key to making progress.

LESSONS LEARNED:

- Cross-departmental communication and idea sharing can lead to a variety of creative solutions
- Build a culture of sustainability that empowers individuals at every level of the organization to act

LOOKING FORWARD: Continual improvement

In Spring 2010, the Green IT subcommittee published a **comprehensive set of Green IT standards**, which were updated again in 2015. These standards provide progress reports that span all of Harvard's Schools, offering best practices from controlling inefficient cooling in data centers to energy metering to campus-wide duplex printing defaults.

While much has been achieved in the area of sustainable IT practices at Harvard, the University is continually learning and researching how to improve its green computing practices on campus. Other areas of green IT include the following:

1. Minimizing e-waste is a major area of focus that has presented some challenges. Work-issued cell phones, for example, are often replaced every two years or so, often enough for employees to accumulate a drawer full of unused electronics that contain proprietary data. While Harvard conducts e-waste drives that include pick-ups for all manner of electronica, it is looking for vendors that can erase data from small electronics to reassure individual users of due diligence.

Larger electronics, such as servers and storage nodes, are another challenge, as there are costs associated with maintaining aging systems. Computer parts typically last four to five years, at which point the machine is disassembled, and up to 50% of the machine is reused in new technology. Similar to small electronics, environmentally sound disposal of servers requires vigilance in tracking the chain of custody, guaranteeing security around data elimination, and recovering parts.

Another aspect of managing e-waste starts with purchasing decisions. Some laptops, for example, are built with increasingly smaller processors—which is good, except that the compromise is that the remaining space beneath the motherboard is devoted to more lithium-ion batteries, which contain a range of toxic substances that are harmful to human health and to the environment.

2. Intelligent building systems, software that integrates building operations and can provide continuous commissioning for improved functionality, present an opportunity for Harvard as it moves forward with renovations and new construction plans. Intelligent building systems would automate the collection and analysis of building operational data and determine where faults and opportunities exist, and then generate reports to help inform building managers of potential areas to improve comfort, safety, productivity, and energy efficiency.

3. Cloud computing, which Harvard is aggressively pursuing, is another challenge, as it becomes necessary to investigate how cloud computing and storage providers are managing sustainable IT themselves. Part of what the University has committed to through its Sustainability Plan is making sustainability efforts not just through on-campus operations, but through purchasing agreements with its vendors. Thus, working with vendors that have energy-efficient data centers and sustainable e-waste practices are an important criterion as well.

4. Endpoint management, or individual computer users and behavior, is an area Harvard continues to explore. Smart-power strips and workstation power management devices were rolled out in phases throughout all campus schools and departments. Future plans look to leverage the incremental improvements enabled in new hardware designs and new generations of operating systems for more efficient power management.

ADDITIONAL RESOURCES:

- Harvard's Green Office Program offers an "a la carte" point system for setting up green IT-related office functions such as default duplex printing, smart-power strips, and shared printing stations
- Harvard has additional Green IT case studies available at green.harvard.edu
- In 2014, Harvard launched a comprehensive Sustainability Plan for 2015-2020

ABOUT HARVARD'S COMMITMENT TO SUSTAINABILITY

Harvard is confronting the challenges of climate change and sustainability through research across disciplines, giving our students the tools to tackle complex global challenges, and acting on campus to model an institutional pathway to a more sustainable future. The Harvard **Sustainability Plan**, launched in 2014, provides the roadmap for building a healthier, more sustainable campus community. The Plan aligns the University under a set of goals and priorities in five key topic areas – energy and emissions, campus operations, nature and ecosystems, health and wellbeing, and culture and learning.

In 2008, President Drew Gilpin Faust and the Deans approved Harvard University's most ambitious sustainability goal: a long-term commitment to reduce the University's greenhouse gas emissions by the maximum practicable rate aligned with the best available science, and a short-term goal to reduce greenhouse gas emissions 30% by 2016, including growth, from a 2006 baseline.

The Harvard Office for Sustainability brings faculty, students, and staff together to set and achieve goals for a healthier, more efficient and sustainable future. By connecting research and teaching with on-campus action, OFS works to model scalable and cost-effective solutions that enhance the well-being of the campus community and ultimately strengthen the University's academic mission.

Credit: James Cuff, FAS Assistant Dean of Research Computing; Eric D'Souza, Senior Project Manager, Harvard University IT; Jennifer Haugh, Sustainability Manager, Office for Sustainability